States of Matter

A = 4 times rate of B.

1. Calculate the ratio of effusion rates of oxygen (O_2) to hydrogen (H_2). $\frac{rate_A}{rate_B} = \sqrt{\frac{2g}{32g}}$

2. Methane (CH_4) effuses at a rate of 2.45 mol/s. What will be the effusion rate of argon (Ar) under the same conditions? $\frac{2.45 mol/s}{x} = \sqrt{\frac{39.9g}{16g}}$ rate of Ar = 1.55 mol/s

3. The effusion rate of hydrogen sulfide (H_2S) is 1.50 mol/s. Another gas under similar conditions effuses at a rate of 1.25 mol/s. What is the molar mass of the second gas? $\frac{1.50 mol/s}{1.25 mol/s} = \sqrt{\frac{x}{34.1g}}$ 49 g.

4. The pressure of a gas in a manometer is 12.9 mm Hg. Express this value in each of the following units.

   a. torr $12.9 mm Hg \left(\frac{760 torr}{760 mm Hg}\right) = 12.9 Torr$

   b. atmosphere $12.9 mm Hg \left(\frac{1 atm}{760 mm Hg}\right) = 0.0169 atm$

   c. kilopascal $12.9 mm Hg \left(\frac{101.3 kPa}{760 mm Hg}\right) = 1.72 kpa$

5. The vapor pressure of water is 2.3 kPa at 23°C. What is the vapor pressure of water at this temperature expressed in atmospheres?

$2.3 Kpa \left(\frac{1 atm}{101.3 Kpa}\right) = 0.023 atm.$

6. What is the pressure of a mixture of nitrogen (N_2) and oxygen (O_2) if the partial pressure of N_2 is 594 mm Hg and the partial pressure of O_2 is 165 mm Hg? $P_T = 594 + 165 = 759 mm Hg$

7. A sample of air is collected at 101.1 kPa. If the partial pressure of water vapor in the sample is 2.8 kPa, what is the partial pressure of the dry air? P_T = Dry Air + Wet air

   $101.1 KPa = x + 2.8 kpa$ $x = 98.5 Kpa$

8. Suppose that 5-mL containers of helium (He), neon (Ne), and argon (Ar) are at pressures of 1 atm, 2 atm, and 3 atm, respectively. The He and Ne are then added to the container of Ar.

   a. What is the partial pressure of He in the container after the three gases are mixed? 1 atm.

   b. What is the total pressure in the container after the three gases are mixed? 6 atm.

$\frac{rate_A}{rate_B} = \sqrt{\frac{molar\ mass_B}{molar\ mass_A}}$

$1 atm = 760 torr = 760 mm Hg = 101.3 Kpa = 14.7 psi$

$P_T = P_1 + P_2 + P_3 \ldots$

States of Matter

Section 13.1 Gases

In your textbook, read about the kinetic-molecular theory.

Complete each statement.

1. The kinetic molecular theory describes the behavior of gases in terms of particles in ___motion___.
2. The kinetic-molecular theory makes the following assumptions.
   a. In a sample of a gas, the volume of the gas particles themselves is very ___small___ compared to the volume of the sample.
   b. Because gas particles are far apart, there are no significant attractive or repulsive ___forces___ between gas particles.
   c. Gas particles are in constant and ___random___ motion.
   d. The collisions between gas particles are ___elastic___; that is, no ___kinetic___ energy is lost.
3. The kinetic energy of a particle is represented by the equation ___$KE = \frac{1}{2}mv^2$___.
4. ___Temperature___ is a measure of the average kinetic energy of the particles in a sample of matter.

In your textbook, read about explaining the behavior of gases.

For each statement below, write *true* or *false*.

___T___ 5. Gases are less dense than solids because there is a lot of space between the particles of a gas.

___T___ 6. The random motion of gas particles causes a gas to expand until it fills its container.

___F___ 7. The density of a gas decreases as it is compressed.

___T___ 8. A gas can flow into a space occupied by another gas.

___T___ 9. The diffusion of a gas is caused by the random motion of the particles of the gas.

___F___ 10. Lighter gas particles diffuse less rapidly than do heavier gas particles.

___T___ 11. During effusion, a gas escapes through a tiny opening into a vacuum.

___F___ 12. Graham's law of effusion states that the rate of effusion for a gas is directly related to the square root of its molar mass.

Section 13.1 *continued*

In your textbook, read about gas pressure.

Circle the letter of the choice that best completes the statement or answers the question.

13. Pressure is defined as force per unit
a. area. **b.** mass. **c.** time. **d.** volume.

14. What is an instrument designed to measure atmospheric pressure?
a. barometer **b.** manometer **c.** sphygmomanometer **d.** thermometer

15. The height of the liquid in a barometer is affected by all of the following EXCEPT the
a. altitude.
b. atmospheric pressure.
c. density of the liquid in the column.
d. diameter of the column tube.

16. The pressure of the gas in a manometer is directly related to which of the following quantities?
a. height of the mercury column in the closed-end arm
b. height of the mercury column in the open-end arm
c. a + b
d. a − b

17. One atmosphere is equal to a pressure of
a. 76 mm Hg. **b.** 101.3 kPa. **c.** 147 psi. **d.** 706 torr.

18. The partial pressure of a gas depends on all of the following EXCEPT the
a. concentration of the gas.
b. identity of the gas.
c. size of the container.
d. temperature of the gas.

19. The pressure of a sample of air in a manometer is 102.3 kPa. What is the partial pressure of nitrogen (N_2) in the sample if the combined partial pressures of the other gases is 22.4 kPa?
a. 62.4 kPa **b.** 79.9 kPa **c.** 102.3 kPa. **d.** 124.7 kPa

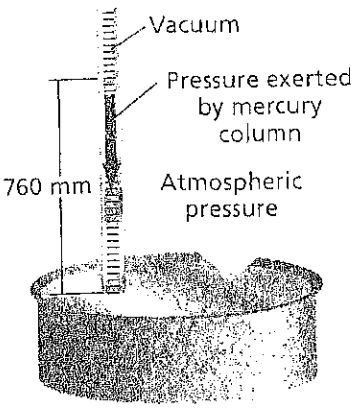
Use the figure to answer the following questions.

20. What instrument is illustrated in the figure? Barometer

21. Who invented this instrument? Torricelli

22. What are the two opposing forces that control the height of the mercury in the column?
Atmospheric pressure, gravity

23. What does it mean when the level of mercury rises in the column?
atmospheric pressure is increasing



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Section 13.2 Forces of Attraction

In your textbook, read about forces of attraction.

Answer the following questions.

1. Ionic, metallic, and covalent bonds are examples of what type of forces? Intramolecular

2. Dispersion forces, dipole–dipole forces, and hydrogen bonds are examples of what type of forces? Intermolecular

3. Describe dispersion forces.
non polar molecules create a temporary dipole and an attraction occurs between the nucleus of one atom and the electron cloud of another.

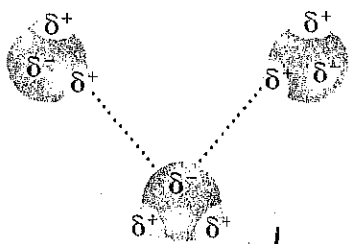
4. Dispersion forces are greatest between what type of molecules?

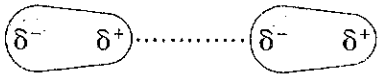
5. Describe a permanent dipole.
the electronegativity difference between atoms in a molecule are large enough so that electrons are more strongly attracted to atom than the other.

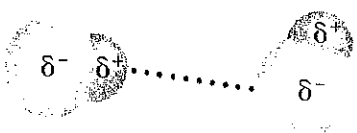
6. Describe dipole–dipole forces.
the positive end of one molecule is attracted to the negative end of another molecule

7. Describe a hydrogen bond.

8. Identify each of the diagrams below as illustrating dipole–dipole forces, dispersion forces, or hydrogen bonds.







a. Hydrogen bonding b. dispersion c. dipole - dipole

9. Rank dipole–dipole forces, dispersion forces, and hydrogen bonds in order of increasing strength.
dispersion, dipole - dipole, Hydrogen bonding

Section 13.3 Liquids and Solids

In your textbook, read about liquids and solids.

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized word or phrase to make it true.

1. The constant *motion* of the particles in a liquid causes the liquid to take the shape of its container.

True 2. At room temperature and one atmosphere of air pressure, the density of a liquid is much *greater* than that of its vapor.

3. Liquids are not easily compressed because their particles are *loosely* packed.

False 4. A liquid is less fluid than a gas because ~~*intramolecular*~~ intermolecular attractions interfere with the ability of particles to flow past one another.

True 5. Liquids that have stronger intermolecular forces have *higher* viscosities than do liquids with weaker intermolecular forces.

False 6. The viscosity of a liquid ~~*increases*~~ decreases with temperature because the increased average kinetic energy of the particles makes it easier for the particles to flow.

True 7. Liquids that can form hydrogen bonds generally have a *high* surface tension.

True 8. A liquid that rises in a narrow glass tube shows that the adhesive forces between the particles of the liquid and glass are *greater* than the cohesive forces between the particles of the liquid.

True 9. Solids have a definite shape and volume because the motion of their particles is limited to *vibrations* around fixed locations.

False 10. Most solids are ~~*less*~~ more dense than liquids because the particles in a solid are more closely packed than those in a liquid.

False 11. Rubber is *a* ~~*crystalline*~~ amorphous. solid because its particles are not arranged in a regular, repeating pattern.

Section 13.4 Phase Changes

In your textbook, read about phase changes.

Complete the table by writing the initial and final phases for each phase change and making a check (✓) in the correct energy column.

Phase Change	Phase		Energy	
	initial	final	required	released
1. Condensation	gas	liquid		✓
2. Deposition	gas	solid		✓
3. Freezing	liquid	solid		✓
4. Melting	solid	liquid	✓	
5. Sublimation	gas	solid	✓	
6. Vaporization	liquid	gas	✓	

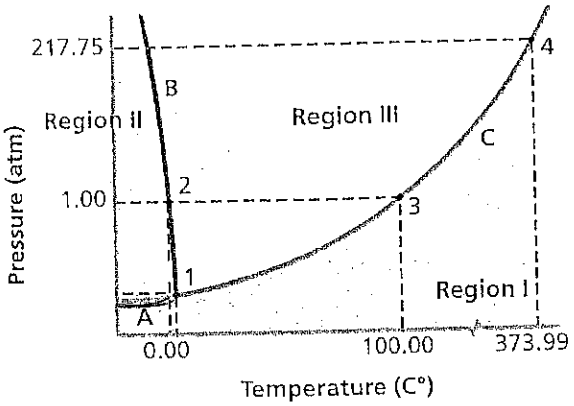
For each item in Column A, write the letter of the matching item in Column B.

Column A	Column B
B 7. Temperature at which a liquid is converted into a crystalline solid	a. boiling point
C 8. Temperature at which the forces holding a crystalline lattice together are broken	b. freezing point
A 9. Temperature at which the vapor pressure of a liquid equals the external or atmospheric pressure	c. melting point

Section 13.4 *continued*

In your textbook, read about phase diagrams.

Use the phase diagram for water to answer the following questions.



10. What variables are plotted on a phase diagram?

Pressure and Temperature.

11. What phase of water is represented by each of the following regions?

a. Region I Gas

b. Region II Solid

c. Region III liquid

12. What does point 2 represent?

melting point

13. What is the temperature at point 3?

100°C

14. What does line A represent?

Temperatures and pressures at which sublemation occurs.

15. What is point 4 called? What does it represent?

Critical point. Temperature and pressure at which a substance can not longer exist as a liquid.